

ATTACHMENT 1

Strain Requirements in an “Ultimate Splice”

The following tables list the maximum allowable strain demands and the minimum required strain capacities in the base rebar and the splice assemblies for each category of splices. The proposed strain values are based on many pull tests of reinforcing bar conducted by METS.

Table 1 Strain Demands and Capacities for Bars and Splices in A706M Steel

Splice Category	Minimum Required Strain Capacity		Maximum Allowable Strain Demand	Factor of Safety (F.S.)
	Rebar Only	Rebar + Splice		
1 Ultimate	6% for #36 and larger 9% for #32 and smaller	6% for #36 and larger 9% for #32 and smaller	<2%	3 to 4.5
2 Service	Same as above	>2% for all rebar sizes	<0.2% (yield strain of rebar)	>10
3 Lap (or Welded/Mechanical Lap in lieu of Lap)	Same as above	>0.2%	<0.15% (unfactored loads) <0.2% (factored loads)	1.33

The factor of safety (F.S.) is defined as the minimum required strain capacity divided by the maximum allowable strain demand in a splice.

Table 2 Strain Demands and Capacities for Bars and Splices in A615M, Grade 300 to A706M Splicing

Splice Category	Minimum Required Strain Capacity		Maximum Allowable Strain Demand	Factor of Safety (F.S.)
	Rebar Only	Rebar + Splice (strain measured on Grade 300 side only)		
1 Ultimate	9% for #36 and larger 12% for #32 and smaller	9% for #36 and larger 12% for #32 and smaller	<2%	4.5 to 10
2 Service	Same as above	>2% for all rebar sizes	<0.2% (yield strain of rebar)	>10
3 Lap (or Welded/Mechanical Lap in lieu of Lap)	Same as above	>0.2%	<0.15% (unfactored loads) <0.2% (factored loads)	1.33

The issue of a high factor of safety (F.S.) needs to be addressed because of the confusion it may create in comparison to the more traditional F.S. values. Typically, in linear/elastic analysis, a F.S. of 2 is generally adequate and acceptable. Therefore, a F.S. of 10 required for reinforcement strain in a non-linear seismic approach may seem excessive. As an example, consider two sections in the column of a single-column bent under transverse bending. In the first section, taken at a location where the moment demand is M_y , the strain demand in the main reinforcement is approximately 0.2%. However, at the second section taken at a distance of distance of 0.15L

ATTACHMENT 1

(L is column height) from the previous section, and towards the footing where the moment would be M_p , the strain demand would be approximately 1% because of the non-linear nature of the stress-strain curve for a rebar. Therefore, a small change in the location of a section (15% of column length) could cause a five-fold increase in strain in the reinforcement, thereby necessitating high F.S. values such as 10.

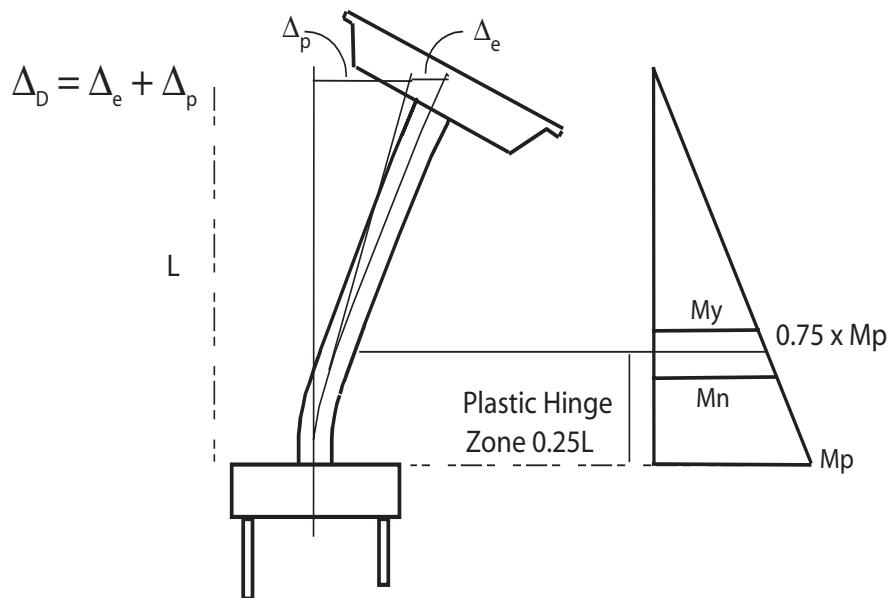


Figure 1 Moment Demand on Single Column Bents

ATTACHMENT 1

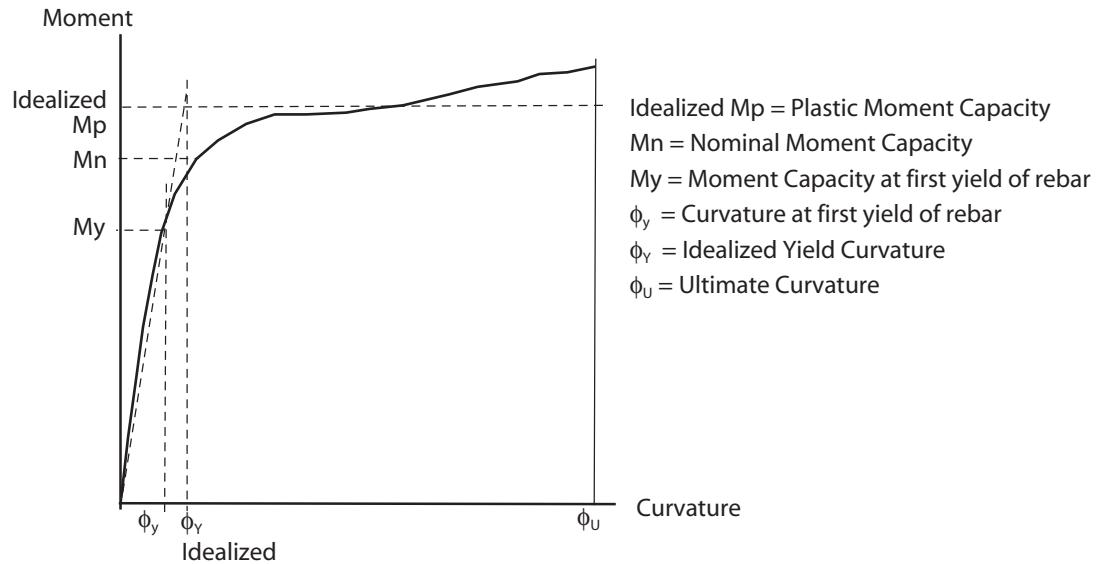


Figure 2 Moment-Curvature Curve

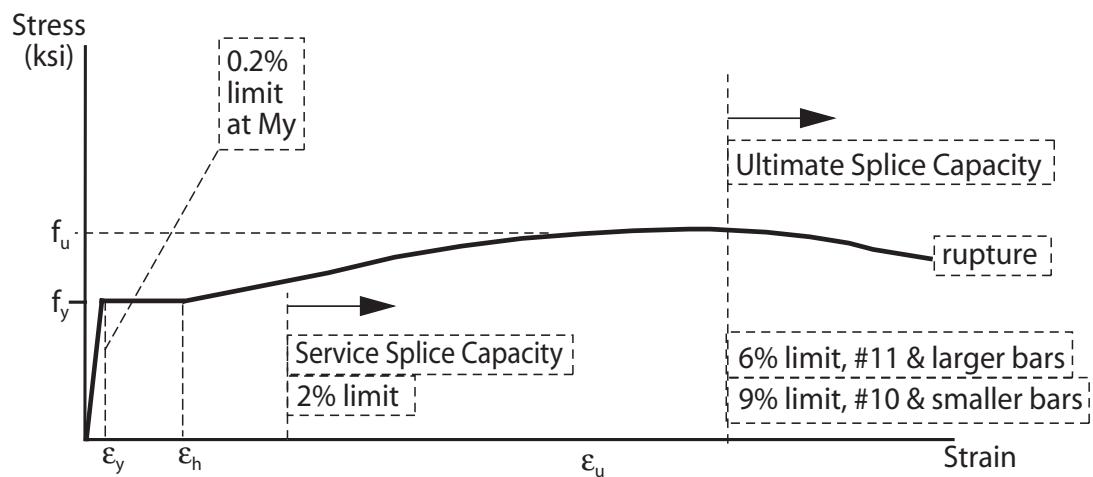
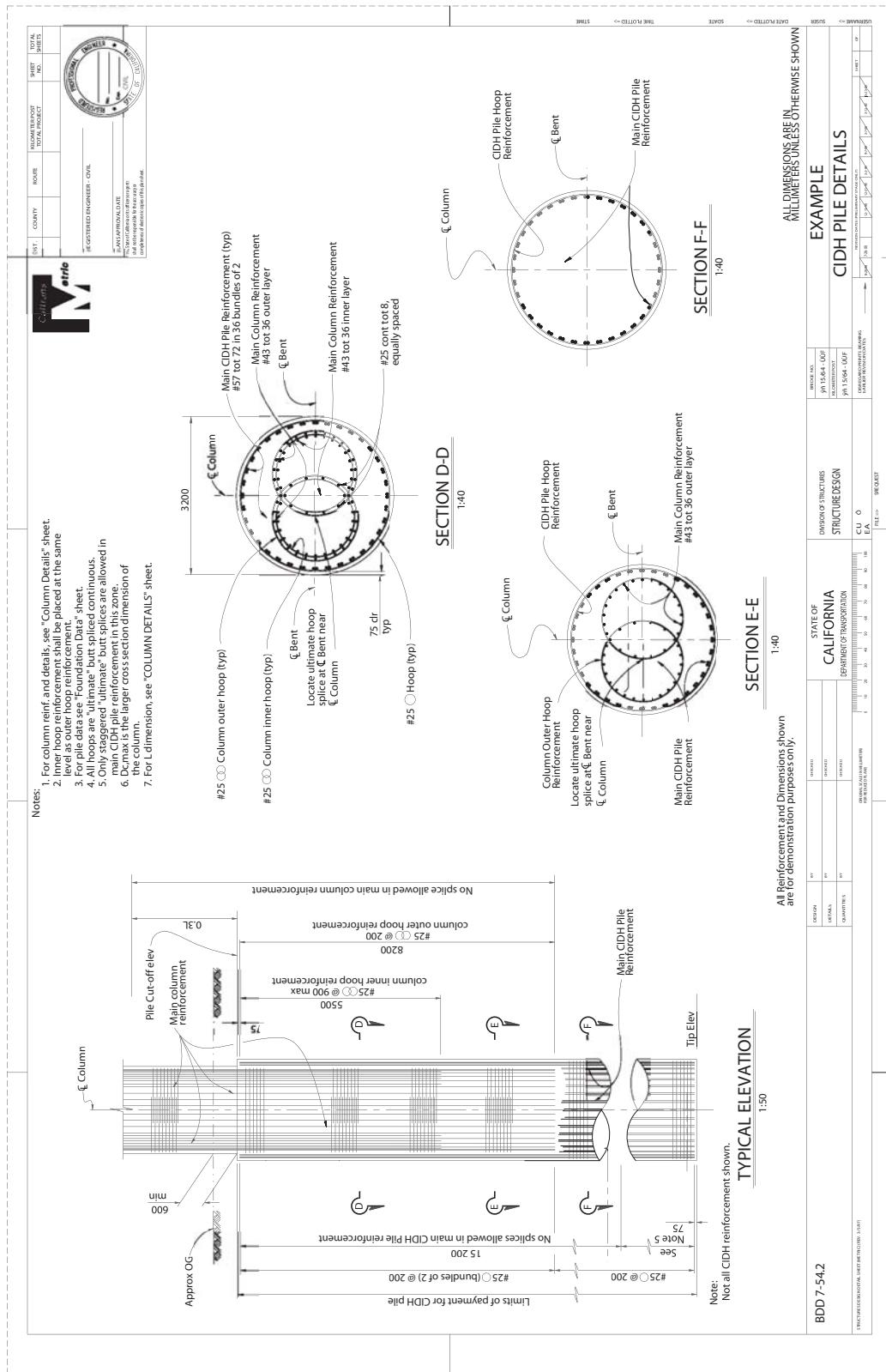


Figure 3 Stress-Strain Curve

ATTACHMENT 1



ATTACHMENT 1

